Storage of Rice. XIII.

Storage of Rice in Tin Containers with Calcium Chloride, with Special Reference to the Underdried Product. II.

By

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I. Introduction.

In the preceding experiment[1] the authors obtained results which show that rice with a moisture content of 14.2 and 16.9 per cent, stored hermetically in tin containers from April to October with calcium chloride in the proportion of three kgs. to one *Koku* of hulled rice, lost 1.5 and 1.7 per cent of moisture respectively. Since it is important to determine the monthly loss in moisture, the authors repeated the experiment, removing portions for analysis at intervals of 29 to 31 days.

II. Method of Experiment.

In this experiment the authors used the same tin containers with a capacity of 5 *Koku* as in the preceding experiment. As experimental material, two lots of rice of the harvest of 1933 with a moisture content of 14.8 per cent and 15.7 per cent respectively were used. The rice was sealed hermetically in the large tin containers and stored from January 22 to December 16, 1934. Three kgs. of $CaCl_2$ were added for each *Koku* of hulled rice. Each month the quantity of water absorbed by $CaCl_2$ was determined. On December 16, after nearly eleven months storage, the containers were opened and the rice was examined with reference to its quality and its germinating power.

The quantity of rice, its moisture content and the quantity of $CaCl_2$ used were as follows :

1) Kondō, M. and Okamura, T., Storage of Rice. XII. Storage of Rice in Tin Containers with Calcium Chloride, with Special Reference to the Underdried Product. I. Ber. Ōhara Inst. f. landw. Forsch., Bd. VI, Ht. 2, S. 335—339, 1934.

Moisture of hulled rice	Quantity of rice	Quantity of $CaCl_2$
14.8%	4.7 *Koku*	3 kgs. for each *Koku* of rice
15.7%	4.8 *Koku*	3 kgs. for each *Koku* of rice

III. Results of Experiment.

1) Extent of Desiccation.

Each month the quantity of water absorbed by $CaCl_2$ was determined and the moisture content of the rice was calculated. The results are shown in the following table:

Quantity of Water Absorbed by $CaCl_2$ and Moisture Content of Rice Kernels.

Date of determination	Initial moisture content of rice 14.8%*			Initial moisture content of rice 15.7%**		
	Water absorbed by $CaCl_2$ of 14.1 kgs.	Water absorbed each month	Moisture content of rice	Water absorbed by $CaCl_2$ of 14.4 kgs.	Water absorbed each month	Moisture content of rice
	kg.	kg.	%	kg.	kg.	%
Feb. 21	1.337	1.337	14.6	1.530	1.530	15.5
March 22	2.271	0.934	14.5	2.542	1.012	15.4
April 22	3.424	1.153	14.4	3.850	1.308	15.2
May 22	4.717	1.293	14.2	5.184	1.334	15.1
June 22	6.242	1.525	14.0	6.978	1.794	14.8
July 22	8.504	2.262	**13.7**	9.409	2.431	**14.5**
Aug. 22	10.893	2.389	13.4	11.918	2.509	14.2
Sept. 22	12.093	1.200	13.3	13.478	1.560	14.0
Oct. 22	12.938	0.845	13.2	14.293	0.815	13.9
Dec. 22	13.343	0.203	13.1	14.823	0.265	13.8

* Quantity of rice 4.7 *Koku*.
** Quantity of rice 4.8 *Koku*.

According to the above table, the rice with a moisture content of 14.8 per cent dried during six months, namely until July, to 13.7 per cent and that of 15.7 per cent to 14.5 per cent. Since the moisture content continued to decrease reaching in December 13.1 and 13.8 per cent respectively, the desiccation of the underdried rice was sufficient not merely for one year but also for several years storage. Although during the time of storage, the loss of moisture of the

rice was continuous, in the hot season, namely in July and August, the desiccation was most effective. From January to August, the desiccating power of $CaCl_2$ increased gradually as the weather grew warmer, but after August it decreased gradually, as the weather grew cooler. If it is desired to increase the rate of drying before the summer, calcium chloride should be added in excess of three kgs. for each *Koku* of hulled rice, or else some more quick desiccating material such as calcium oxide should be used. It appears, however, that the above mentioned storage experiment was satisfactory since the drying of the rice during the hot season was most effective and deterioration was checked.

2) General Quality.

On December 16, 1934, at the end of storage, the containers were opened and the general quality of the rice was determined. The two lots of rice with an initial moisture content of 14.8 and 15.7 per cent had dried during storage to a moisture content of 13.1 and 13.8 per cent respectively, which is just the amount required for safe storage. The two lots were consequently preserved in perfect condition without any change in taste. As regards the lot containing 15.7 per cent of moisture, it may be said that rice underdried as that extent is stored with difficulty through the summer in this locality, if the ordinary method in straw-bags is followed. The method of storage in tin containers employing $CaCl_2$ to absorb the excess of moisture is certainly effective when the rice is underdried.

3) Germinating Power.

Portions of the rice were taken from different parts of the tin containers and their germinating power was determined. The results show that, the vitality varied according to the place in the container. The average percentage of germinating power of the rice with an initial moisture content of 14.8 per cent was 62.8 per cent and that of the rice with a moisture content of 15.7 per cent was 18.5 per cent. In spite of the unsatisfactory germinating power, which was anticipated, the condition in this respect was much better than when the storage is in the straw-bags. The germinating power of rice with a moisture content, as high as 15 and 16 per cent stored in straw-bags will be lost entirely after a lapse of one year.

IV. Discussion.

In the earlier experiment[1] lots of hulled rice with a moisture content of 14.2 and 16.9 per cent were stored hermetically in tin containers, with three kgs. of $CaCl_2$ for each *Koku* of rice. The results obtained show that the rice lost 1.5 and 1.7 per cent of moisture respectively during the time of storage from April to October. The general quality of the rice with an initial moisture content of 14.2 per cent was quite good and the germinating capacity was 93 per cent. The general quality of the rice with an initial moisture content of 16.9 per cent was not so good, but the grain came out of storage in fairly good condition. Its germinating capacity was 40 per cent.

In the experiment here described, it was found that rice with a moisture content of 14.8 and 15.7 per cent stored with $CaCl_2$ kept in quite good condition as detailed above.

From both experiments, it may be concluded that, not only rice with a moisture content of 14 to 15 per cent, but also underdried rice with a moisture content of 16 to 17 per cent can be safely kept for one year or perhaps longer, if it is sealed in a tin container together with three kgs. of $CaCl_2$ for each *Koku* of grain. Farmers throughout the whole country, from the south to the north, should be encourraged to follow this method of storage when the grain is underdried. In the northern sections underdried rice with a moisture content of 16 to 17 per cent can be moderately dried during storage and preserved in good condition. The results obtained indicate that, the warmer the weather the more effective the absorption of moisture by $CaCl_2$, the absorption being greatest during July and August. It is thus evident that the desiccation by $CaCl_2$ is most complete when the temperature conditions are such as to promote the greatest deterioration. Of course the tin containers must be so constructed as to secure thorough and quick drying.

V. Summary.

1. Two lots of rice with a moisture content of 14.8 and 15.7 per cent respectively were stored in tin containers with a capacity of 5 *Koku*. Three kgs. of $CaCl_2$ were added for each *Koku* of hulled rice and the containers were sealed hermetically. The rice was harvested in 1933 and the storage in the tin containers was from January to December 1934.

2. Once a month, the quantity of water, which the $CaCl_2$ absorbed from the rice, was determined and the moisture content of the rice was calculated.

3. The results obtained show that the rice with a moisture content of 14.8 and 15.7 per cent stored from January to December lost 1.7 and 1.9 per cent of moisture respectively and the loss in both lots was progressive.

4. The rate of absorption of moisture by $CaCl_2$ increased as the weather grew warmer and was greatest during July and August. Rapid drying during these months is particularly desirable since summer heat greatly accelerates deterioration.

5. The general quality of both lots of rice was excellent and the germinating capacity was 62.8 and 18.5 per cent respectively. The taste of the boiled rice was quite good.

6. The use of tin containers for the storage of rice with the addition of 3 kgs. $CaCl_2$ for each *Koku* of hulled grain can be recommended to farmers throughout the whole country, from south to north. Rice in northern localities, even when containing a moderate excess of moisture, will be dried by this method sufficiently during storage to prevent deterioration.